PROCEEDINGS

OF

THE ROYAL SOCIETY.

1835—1836. No. 23.

December 10, 1835.

FRANCIS BAILY, Esq., Vice-President and Treasurer, in the Chair.

The following communication from the President to the Fellows of the Royal Society was read:

"GENTLEMEN,

"At the opening of the Session I think it right to express my anxiety to come amongst you again; and I therefore trust that I need not repeat that as soon as my present infirmity is removed you may be sure of my readiness to take the chair. In the mean time I hope that the Members will not relax in their endeavours to uphold the character of the Royal Society; and I shall look with confidence to the attendance of the Vice-Presidents for the maintenance of that order and regularity so necessary to be observed at all literary and scientific meetings.

"Kensington Palace, Dec. 10, 1835. "AUGUSTUS F., P.R.S."

The following papers were read:

"Memoranda taken during the continuance of the Aurora Borealis of November 18, 1835." By Charles C. Christie, Esq. Communicated by Samuel Hunter Christie, Esq., F.R.S.

The appearances described were seen from Deal, on the day mentioned in the title, from 9 to 20 minutes past 10 o'clock in the evening; and consisted chiefly of a bright arch of light, of which the lower edge was sharply defined, surmounted on a dark cloud below, while the upper edge was shaded off into the cloudless and starlight sky, emitting large but faint luminous streaks, which issued upwards with great rapidity, exactly imitating flames agitated to and fro by a violent wind.

"Démonstration complète du Théorème dit de Fermat: par François Paulet, de Genève, ancien élève de l'E'cole Polytechnique." Communicated by P. M. Roget, M.D., Sec. R.S.

The theorem of which the author professes to give, in this paper, the complete demonstration, is the following: "No power, beyond the second degree, of any quantity, can exist, capable of being resolved into the sum, or the difference, of two other powers of the same degree:" or, as it may still more generally be expressed, "If the exponents of three powers be multiplied by the same number, provided that number be greater than 2, neither the sum, nor the difference, of any two of the resulting quantities can ever be equal to the third quantity."

It was resolved unanimously,—"That the thanks of this Society be given to their Secretary John George Children, Esq., for the zeal and ability which he has uniformly displayed, and the many valuable services he has rendered, in promoting its objects."

December 17, 1835.

SIR JOHN RENNIE, Knt., Vice-President in the Chair.

"Researches towards establishing a theory of the Dispersion of Light, No. II." By the Rev. Baden Powell, M.A., F.R.S., Savilian Professor of Geometry in the University of Oxford.

The author, in a preceding paper, published in the last part of the Philosophical Transactions, commenced a comparison between the results of M. Cauchy's system of undulations, expressing the theoretical refractive index for each of the standard rays of the spectrum, and the corresponding index found from observation in different media. Since that paper was communicated, he has received the account of a new series of results obtained by M. Rudberg, and comprising the indices for the standard rays in a prism of calcareous spar, and in a prism of quartz, both for the ordinary and the extraordinary rays; and also the ratios of the velocities in the direction of the three axes of elasticity, respectively, in Aragonite and Topaz. The author was accordingly led to examine this valuable series of data, and the comparison of them with the theory forms the subject of the present paper. He finds the coincidences of theory and observation to be at least as close as those already obtained from Frauenhofer's results, and to afford a satisfactory extension of the theory to ten new cases, in addition to those already discussed; and a further confirmation of the law assigned by the hypothesis of undulations.

A paper was in part read, entitled, "On the action of Light upon Plants, and of Plants upon the Atmosphere." By Charles Daubeny, M.D., F.R.S., Professor of Chemistry and of Botany in the University of Oxford.

The Society then adjourned over the Christmas Vacation to meet again on the seventh of January next.

January 7, 1836.

FRANCIS BAILY, Esq., Vice-President and Treasurer, in the Chair.

A paper was read, entitled, "Meteorological Journal kept at the Royal Observatory, Cape of Good Hope, from the 1st of June to the 31st of December, 1834." Communicated by Capt. Beaufort, R.N., F.R.S., Hydrographer to the Admiralty.

The observations recorded in this Journal are those of the barometer, and of two thermometers, one in, and the other out of doors; taken at sunrise, noon, sunset, and midnight, in each successive day from the 1st of June, 1834, to the end of the year.

"Some Account of the Volcanic Eruption of Cosiguina in the Bay of Fonseca, commonly called the Coast of Conchagua, on the Western Coast of Central America." By Alexander Caldcleugh, Esq., F.R.S.

The particulars recorded in this narrative are derived partly from a voluminous collection of official reports transmitted from the authorities in various towns to the government of Central America, and partly from the information of intelligent eye-witnesses of the phenomena. The eruption occurred on the 19th of January, 1835, and was preceded by a slight noise, accompanied with a column of smoke issuing from the mountain, and increasing till it took the form of a large and dense cloud, which, when viewed from a distance of ten leagues to the southward, appeared like an immense plume of white feathers, rising with considerable velocity and expanding in every direction. Its colour was, at first, of the most brilliant white; but it gradually became tinged with grey; then passed into yellow; and finally assumed a beautiful crimson hue. In the course of the following days several shocks of an earthquake were felt, the last of which were most terrific. On the morning of the 22nd, the sun had risen in brightness; but a line of intense darkness denoted the presence of the same cloud which had before presented such remarkable appearances, and which, extending with great rapidity, soon obscured the light of day; so that in the course of half an hour the darkness equalled in intensity that of the most clouded night: persons touched without seeing one another; the cattle hurried back to their folds; and the fowls went to roost, as on the approach of night. This atmospheric darkness continued with scarcely any diminution for three days; during the whole of which time there fell a fine impalpable dust, covering the ground at St. Antonio to the depth of two inches and a half, and consisting of three layers of different shades of grey colour: and for ten or twelve succeeding days the sky exhibited a dim and murky light. At Nacaome, to the northward of the volcano, the same degree of darkness was experienced, and the deposit of ashes was from four to five inches in depth, and exhaled a fetid sulphureous odour, which penetrated through every interstice in the buildings. The complete obscurity was only occasionally broken by the lightning, which flashed in every direction, while the air was rent with loud and reiterated explosions like the discharges of artillery, which accompanied each eruption of volcanic matter, and conspired to strike the deepest terror, and to spread among the inhabitants a universal panic that the day of judgement was arrived. On the 24th the atmosphere became clearer, and the houses were found covered to the depth of eight inches with ashes, in which many small birds were found suffocated. Deer and other wild animals flew to the town for refuge, and the banks of the neighbouring streams were strewed with dead fish. In Segovia, and as far as eight leagues from the volcano, the showers of black sand were so abundant as to destroy thousands of cattle; and many were subsequently found whose bodies exhibited one mass of scorched flesh.

Within the Bay of Fonseca, and two miles from the volcano, it is stated that two islands, from two to three hundred yards in diameter, were thrown up, probably from the deposit of masses of scoriæ on previously existing shoals.

It was resolved unanimously:—"That the thanks of this Society be given to their Secretary Peter Mark Roget, Doctor of Medicine, for the zeal and ability which he has uniformly displayed, and the many valuable services he has rendered in promoting its objects."

January 14, 1836.

FRANCIS BAILY, Esq., V.P., and Treasurer in the Chair.

Dr. Daubeny's paper entitled, "On the action of Light upon Plants, and of Plants upon the Atmosphere," was resumed and concluded.

The objects of the experimental inquiries of which the author gives an account in this paper were, in the first place, to ascertain the extent of the influence of solar light in causing the leaves of plants to emit oxygen gas, and to decompose carbonic acid, when the plants were either immersed in water, or surrounded by atmospheric air. The plants subjected to the former mode of trial were *Brassica oleracea*, *Salicornia herbacea*, *Fucus digitatus*, *Tussilago hybrida*, *Cochlearia armorica*, *Mentha viridis*, *Rheum rhaponticum*, *Allium ursinum*, and several species of *Gramineæ*. Geraniums were the only plants subjected to experiment while surrounded with atmospheric air. Comparative trials were made of the action on these plants of various kinds of coloured light, transmitted through tinted glass, of which the relative calorific, illuminating, and chemical powers had been previously ascertained; and the results of all the experiments are recorded in tables; but no general conclusion is deduced from them by the author. He next describes a few experiments which he made on beans, with a view to ascertain the influence of light on the secretion of the green matter of the leaves, or rather to determine whether the change of colour in the chromule is to be ascribed to this agent. The third object of his inquiries was the source of the irritability of the *Mimosa pudica*, from which it appeared that light of a certain intensity is necessary for the maintenance of the healthy functions of this plant, and that when subjected to the action of the less luminous rays, notwithstanding their chemical influence, the plant lost its irritability quite as soon as when light was altogether excluded. He then examines the action of light in causing exhalation of moisture from the leaves; selecting Dahlias, Helianthuses, Tree Mallows, &c., as the subjects of experiment. The general tendency of the results obtained in this series is to show that the exhalation is, *cæteris paribus*, most abundant in proportion to the intensity of the light received by the plant. He also made various comparative trials of the quantity of water absorbed, under different circumstances, by the roots of plants, and chiefly of the *Helianthus annuus*, *Sagittaria sagittifolia*, and the *Vine*. From the general tenor of the results of these and the preceding experiments, he is inclined to infer that both the exhalation and the absorption of moisture in plants, as far as they depend on the influence of light, are affected in the greatest degree by the most luminous rays; that all the functions of the vegetable economy which are owing to the presence of this agent, follow, in this respect, the same law; and that in the vegetable, as well as in the animal kingdom, light acts in the character of a specific stimulus. The author found that the most intense artificial light that he could obtain from incandescent lime produced no sensible effect on plants.

The latter part of the paper is occupied by details of the experiments which the author made with a view to ascertain the action of plants upon the atmosphere, and more especially to determine the proportion that exists between the effects attributable to their action during the night and during the day; and also the proportion between the carbonic acid absorbed, and the oxygen evolved.

His experiments appear to show that at least 18 per cent. of oxygen may be added to the air confined in a jar by the influence of a plant contained within it. He also infers that the stage of vegetable life at which the function of purifying the air ceases, is that in which leaves cease to exist. The author shows that this function is performed both in dicotyledonous and in monocotyledonous plants, in evergreens as well as in those that are deciduous, in terrestrial and in aquatic plants, in the green parts of eculents as well as in ordinary leaves, in Algæ and in Ferns as well as in Phanerogamous families. Professor Marcet has shown that it does not take place in Fungi.

The reading of a paper, entitled, "On the Anatomical and Optical Structure of the Crystalline Lenses of Animals, being the continuation of the paper published in the Philosophical Transactions for 1833." By Sir David Brewster, K.H., LL.D., F.R.S.,—was commenced.

January 21, 1836.

RODERICK IMPEY MURCHISON, Esq., V.P., in the Chair.

George Biddell Airy, Esq., M.A., A.R.; George Budd, B.A. and M.A.; the Rev. Humphrey Lloyd, M.A.; the Rev. William Taylor; and Charles Wheatstone, Esq.; were elected Fellows of the Society.

Sir David Brewster's paper, entitled, "On the Anatomical and Optical Structure of the Crystalline Lenses of Animals, being the continuation of the paper published in the Philosophical Transactions for 1833," was resumed and concluded.

The author has examined the structure of the crystalline lens of the eye of a great variety of animals belonging to each of the four classes of Vertebrata; and has communicated in this paper a detailed account of his observations, arranged according as they relate to structures more and more complex. In a former paper, published in the Philosophical Transactions for 1833, the lens of the Cod fish was taken as the type of the simplest of these structures, in as much as all the fibres of which it is composed converge, like the meridians of a globe, to two opposite points, or poles, of a spheroid or lenticular solid; both of which poles are situated in the axis of vision. The structure which ranks next in respect of simplicity is that exhibited in the Salmon, among fishes; in the Gecko, among reptiles; and in the Hare, among Mammalia. It presents at each pole two septa placed in one continuous line, in different points of which all the fibres proceeding from the one surface to the other have their origin and termination. A structure somewhat more complex is met with in the lenses of most of the Mammalia, and is particularly exemplified in the lion, the tiger, the horse, and the ox. Three septa occur at each pole in the form of diverging lines inclined to one another at angles of 120°. The next degree of complexity is presented in the lens of the whale, the seal, and the bear, which contain, instead of three, four septa on each side, placed at right angles to each other in the form of a cross. In some specimens of lenses of whales and seals the author observed two septa from each pole, forming one continuous line, from each of the extremities of which proceeded two others, which were at right angles relatively to one another: so that there were in all five on each surface. The most complex structure is that of the lens of the elephant, which exhibits three primary septa diverging at equal angles from the pole, and at their extremities bifurcating into two additional septa, which are inclined to each other at angles of 60°, these latter being the real septa, to which the fibrous radiations are principally related. In some lenses of the elephant the author found the three septa immediately proceeding from the poles exceedingly short, and approaching to evanescence; so that he has no doubt that occasionally they may be found to have disappeared, and that the other six septa will then all diverge from the poles, like the radii of a hexagon, at angles of 60°.

In all the preceding cases, where the arrangement of the fibres is symmetrical on the two sides, the septa on the opposite surface of the lens occupy positions which are reversed with respect to one another; thus in the simple case of the double septa at each pole, the line formed by those of the posterior surface is situated at right angles to that formed by the septa of the anterior surface. Where there are three divergent septa at each pole, the direction of those on the one side bisect the angles formed by those on the other side; and again, where the septa form a rectangular cross, those of one surface are inclined 45° to those of the other surface.

It follows as a consequence of this configuration of the series of points which constitute the origins and terminations of the fibres, that all the fibres, with the exception only of those proceeding in a direct line from the extremities of any of the septa, must, in their passage from the one surface to the other, follow a course more or less contorted; and must form lines of double curvature; that is, curves of which none of the portions lie in the same plane.

The fibres of the lenses of quadrupeds gradually diminish in size from the equator or margin of the lens, where they are largest, to their terminations in the anterior or posterior septa. They are united together by small teeth like those of fishes; but, generally speaking, the teeth are smaller and less distinctly pronounced, and sometimes they are not seen without great difficulty.

In the lens of the turtle, as well as in that of several fishes, the arrangement of the fibres, instead of being symmetrical on the two sides, as is the case in all the preceding instances, is different on the anterior and posterior surfaces; there being two septa on the former, but none in the latter, which presents only a single polar point of convergence.

The author has directed much of his attention to the optical properties of these structures. The lens of the salmon depolarizes three series of luminous sectors; the inner and outer series being negative, and the intermediate series positive. The polarizing structure of the cornea is negative, and it depolarizes very high tints at its junction with the sclerotic coat. When a slice cut from the sclerotica nearly perpendicularly to the surfaces, and with parallel faces, is exposed to polarized light, it exhibits the system of biaxal rectilineal fringes, exactly like those in a plate of glass heated by boiling water or oil, when in the act of rapid cooling. The same alternation of properties with regard to polarization in the successive strata of the substance of the crystalline lenses is exhibited by other fishes which the author examined.

With respect to the final cause of these highly complicated arrangements, it is reasonable to conceive that the gradually increasing density of the fibres in each successive stratum from the surface to the centre is intended to correct spherical aberration: but the design of the other properties resulting from the arrangement of the fibres with reference to septa, in all their variations of number and position, and more especially the alternations of positive and negative structures, as exhibited by the action of the different strata in polarized light, has not even excited the ingenuity of conjecture, and will probably remain among the numerous problems destined to exercise the sagacity of another age.

January 28, 1836.

RODERICK IMPEY MURCHISON, Esq., V.P., in the Chair.

William Clark, M.D.; and Francis Marcet, Esq., were elected Fellows of the Society.

A paper was read, entitled, "Discussion of Tide Observations made at Liverpool." By J. W. Lubbock, Esq., F.R.S.

The chief purpose which the author has in view in presenting the tables accompanying this paper, which are a continuation of those published in the Philosophical Transactions for 1835, and are founded on the observations instituted by Mr. Hutchinson at Liverpool, is to exhibit the diurnal inequality in the height of high water, which is scarcely sensible in the river Thames, but which at Liverpool amounts to more than a foot. The diurnal inequality in the interval appears to be insensible.

The author has farther ascertained that Bernouilli's formulæ expressing the height of the tide, deduced from his theory of the tides, present a very remarkable accordance with observation.

February 4, 1836.

SIR JOHN RENNIE, Knt., Vice-President, in the Chair.

George William Drory, Esq.; Robert Edmund Grant, M.D.; and John Dillwyn Llewelyn, Esq.; were elected Fellows of the Society.

"Geometrical investigations concerning the Phænomena of Terrestrial Magnetism: Second Series,—On the number of points at which a magnetic needle can take a position vertical to the Earth's surface." By Thomas Stephens Davies, Esq., F.R.S. Lond. and Edin., F.R.A.S., of the Royal Military Academy, Woolwich.

This paper is intended as a continuation of the one by the same author published in the last volume of the Philosophical Transactions; in which it was proposed to investigate the mathematical consequences of the hypothesis of the earth being a magnet with two poles, or centres of force, situated anywhere either within, or at the surface, and of equal intensity, but of contrary characters: with the ultimate view of verifying this hypothesis by comparing its results, so deduced, with the phænomena furnished by observation.

In his former paper the author had shown that on this hypothesis the magnetic equator, or the locus of the points at which the magnetic needle takes a horizontal position, is one single and continuous line on the surface of the earth. In this paper his object is to prove that there are always two, and never more than two, points at the earth's surface, at which the needle takes a position vertical to the horizon.

At the close of his former paper the author had deduced the equation of the curve of verticity, that is, of the curve at any point of which an infinitesimal needle being placed, it will always tend towards the centre of the earth, and consequently be vertical to the horizon at its point of intersection with the surface of the earth: but, owing to circumstances over which he had no control, he was unable, at that time, to write out an account of his investigations of the peculiar character of that curve, or to apply its properties to the determination of the latter problem: and these are more especially the objects to which the present paper is devoted.

The processes to which he has had recourse, with this view, are the following. He first transposes the rectangular equation of the curve into a polar equation, and finds that in the result the radius vector is involved only in the second degree; and hence that for every value of the polar angle there are two values of the radius vector, and never more than two; or, in other words, that no line drawn from the centre of the earth can cut the curve of verticity in more than two points. But as no means present themselves of ascertaining whether the values of (r), the polar ordinates of the curve of contact, be always real or not, or how many values of $(\theta_{,})$, the other co-ordinate to that curve, are possible for any given value of r; he abandons this method of inquiry, contenting himself with a few deductions respecting the general form of the locus, and proceeds to employ a different method.

The general system of his reasonings proceeds on the principle that as the magnetic curve itself, and the curve of verticity have one common and dependent genesis, a knowledge of the properties of the former must throw considerable light on those of the latter; and he is accordingly induced to enter into a more minute examination of the magnetic curve than had before been attempted. As both the polar and the rectangular equations of this curve are much too complex to afford any hope of success in their investigation, the author has recourse to a system of co-ordinates, which he terms the "*angular system*," and which was suggested to him originally by the form under which Professor Playfair exhibited this equation in Robison's Mechanical Philosophy. But as he has not yet published his investigations of the differential coefficients, and other formulæ necessary in the application of this system, he puts his results in a form adapted to rectangular co-ordinates; each rectangular co-ordinate being expressed in terms of his angular co-ordinates and the constants of the given equation; and by these means deduces the characters of the magnetic curve throughout its whole course.

The angular equation being

$$\cos\theta_{,} \times \cos\theta_{,,} = 2\cos\beta,$$

he finds, 1°, that the two equations, the convergent and the divergent, or that in which the poles are unlike, and that in which they are like, are both expressed by this equation, and essentially included in it: 2°, that the divergent branches on one side of the magnetic axis are algebraically and geometrically continuous with the convergent branches on the other side; the parameter (β) being the same in both cases: 3°, that the divergent branches are assymptotic, and the assymptote is capable of a very simple construction;

4°, that the continuous branches have the poles as points of inflexion, and that these are the only points of inflexion within finite limits: 5°, that a tangent at any point of the curve, or, which is the same thing, the direction taken by a small needle placed there, admits of easy construction: 6°, that when the parameter (β) is such as to cause the convergent and divergent branches to intersect, they do so in a perpendicular to the magnetic axis drawn from the poles: 7°, that the convergent branches are always concave, and the divergent always convex, to a line at right angles to the magnet, drawn from its middle,—besides other properties not less interesting, though less capable of succinct enunciation.

Having separated the branches belonging to the case of like poles from those belonging to the unlike ones in the magnetic curve, the author proceeds to a similar separation of the corresponding branches in the curve of verticity. In the former case the curve is composed of four branches infinite in length, having the magnetic axis for assymptotes, lying above that axis, and emanating from the poles to the right and left; and of two finite branches, continuous with those just described, and lying below the magnetic axis; one of which passes through the centre of the earth, and meets the other in the perpendicular from the middle of the axis; so that the whole system is constituted by one continuous curve, extending from negative infinite to positive infinite, and having the lines drawn from the centre of the earth to the magnetic poles as tangents at the poles; and no part of the curve lies between these tangents. It bears in form some general resemblance to a distorted conchoid; this curve not having either cusp or loop. In the second case, the curve is also composed of four branches, two finite and two infinite ones; the latter having the line drawn from the centre of the earth through the middle of the magnet as assymptotes, and both lying on the same side of it as the more distant pole; and the finite branches joining these continuously at the poles, and each other in the middle of the magnetic axis; the one from the nearer pole lying above the axis, and the one from the remoter pole lying below it. The branches, where they unite at the poles, have the lines drawn from the centre of the earth to the poles as tangents, and the lower infinite branch passes through the centre. The whole system of branches is comprised between the polar tangents; and the two systems are mutually tangential at the poles, and intersect each other at the centre; but they have no other point in common.

Lastly, the author proceeds to demonstrate that a circle (namely, the magnetic meridian) described from the centre of the curve of verticity, will always cut the convergent system in two points, but can never cut it in more than two. He remarks, however, that if we could conceive two poles of like kinds to exist without any other whatsoever, we might have either four points of verticity, or only two, according to circumstances; but he waves the discussion of this particular case, as being irrelevant to the purpose of his present inquiry.

Mr. Davies announces his intention of shortly laying before the

Society a continuation of these researches; devoting the next series to the points of maximum intensity.

"Memoir on the Metamorphoses in the *Macroura*, or Long-tailed Crustacea, exemplified in the Prawn (*Palæmon serratus*)." By John V. Thompson, Esq., F.L.S., Deputy Inspector-General of Hospitals. Communicated by Sir James Macgrigor, M.D., F.R.S., &c.

The author gives descriptions, illustrated by outline figures, of three different stages of growth of the Prawn; the first being that of the larva immediately on its exclusion from the egg; the second, at a later period, when it has acquired an additional pair of cleft members, and a pair of scales on each side of the tail; and the third, at a still more advanced stage of development, when it presents the general appearance of the adult Prawn, but still retains the natatory division of the members, now increased to six pair. The author thinks it probable that an intermediate stage of metamorphosis exists between the two last of these observed conditions of the animal.

February 11, 1836.

DAVIES GILBERT, Esq., Vice-President, in the Chair.

David Baillie, Esq., and Dr. Archibald Robertson, were elected Fellows of the Society.

A paper was in part read, entitled, "On Voltaic Combinations." In a letter addressed to Michael Faraday, Esq., D.C.L., F.R.S. Fullerian Professor of Chemistry in the Royal Institution of Great Britain, &c., &c. By John Frederick Daniell, Esq., F.R.S., Professor of Chemistry in King's College, London.

February 18, 1836.

FRANCIS BAILY, Esq., Vice-President and Treasurer, in the Chair.

John Green Cross, Esq., was elected a Fellow of the Society.

The reading of Mr. Daniell's paper, entitled, "On Voltaic Combinations," in a letter to Michael Faraday, Esq., D.C.L., F.R.S., &c., was resumed and concluded.

The author, after expressing his obligations to Mr. Faraday for the important light which his late researches in electricity have thrown on chemical science, proceeds to state that in pursuing the train of inquiry which has thus been opened, he has obtained further confirmations of the truth of that great principle discovered and established by Mr. Faraday, namely, the definite chemical action of electricity; and has thence been led to the construction of a voltaic arrangement which furnishes a constant current of electricity for any required length of time.

For the purpose of ascertaining the influence exerted by the different parts of the voltaic battery in their various forms of combination, he contrived an apparatus, which he designates by the name of *the dissected battery*, and which consists of ten cylindrical glass cells, capable of holding the fluid electrolytes, in which two plates of metal are immersed; each plate communicating below, by means of a separate wire, which is made to perforate a glass stopper closing the bottom of the cell, with a small quantity of mercury, contained in a separate cup underneath the stopper, and with which electric communications may be made at pleasure through other wires passing out of the vessel on each side. The active elements of the circuit, which were adopted as standards of comparison, were, for the metals, plates of platinum and amalgamated zinc three inches in length by one in breadth; and for the electrolyte, water acidulated with sulphuric acid, in the proportion of 100 parts by volume of the former to 2·25 of the latter; this degree of dilution (giving a specific gravity of 1·0275,) being adopted, in order to connect the author's experiments with those of Mr. Faraday.

This dilute acid exerts scarcely any local action on amalgamated zinc; because the surface of the metal becomes covered with bubbles of hydrogen gas, which adhere strongly to it; and this force of heterogeneous adhesion appears to have an important influence on the phenomena both of local and of current affinity, and soon puts a stop to the decomposition of the water by the zinc. When a small quantity of nitric acid is added to the acidulated water, the same plate which in the former experiment resisted the action of the diluted sulphuric acid, is, in a few hours, entirely dissolved, without the extrication of any gaseous matter. This result is explained by the author on the supposition that the elements of the nitric acid enter into combination with the hydrogen as it is evolved, and that the opposing attraction of this latter substance is thus removed. The author finds, in like manner, that nascent hydrogen deoxidates copper, and precipitates it from its solutions upon the negative plate of the voltaic circuit.

A series of experiments performed with the dissected battery is next described; illustrating, in a striking manner, the difference of effects with relation to the quantity and the intensity of the electric current, consequent on the different modes of connecting the elements of the battery: the former property being chiefly exhibited when the plates of the respective metals are united together so as to constitute a single pair; and the latter being exalted when the separate pairs are combined in alternate series. The influence of different modifications of these arrangements, and the effects of the interposition of pairs in the reverse order, operating as causes of retardation, are next inquired into.

In the course of these researches, the author, being struck with the great extent of negative metallic surface over which the deoxidating influence of the positive metal appeared to manifest itself, as is shown more especially in the cases where a large sheet of copper is protected from corrosion by a piece of zinc or iron of comparatively very small dimensions, was induced to institute a more careful examination of the circumstances attending this class of phenomena; and was thus led to discover the cause of the variations and progressive decline of the power of the ordinary voltaic battery, one of the principal of which is the departure of the zinc on the platina plates; and to establish certain principles from which a method of counteracting this evil may be derived. The particular construction which he has devised for the attainment of this object, and which he denominates the *constant battery*, consists of a hollow copper cylinder, containing within it a membranous tube formed by the gullet of an ox, in the axis of which is placed a cylindrical rod of zinc. The dilute acid is poured into the membranous tube from above by means of a funnel, and passes off, as occasion requires, by a siphon tube at the lower part; while the space between the tube and the sides of the copper cylinder is filled with a solution of sulphate of copper, which is preserved in a state of saturation by a quantity of this substance suspended in it by a cullender, allowing it to percolate in proportion as it is dissolved. Two principal objects are accomplished by this arrangement; first, the removal out of the circuit of the oxide of zinc, the deposit of which is so injurious to the continuance of the effect of the common battery; and, secondly, the absorption of the hydrogen evolved upon the surface of the copper, without the precipitation of any substance which would lead to counteract the voltaic action of that surface. The first is completely effected by the suspension of the zinc rod in the interior membranous cell into which fresh acidulated water is allowed slowly to drop, in proportion as the heavier solution of the oxide of zinc is withdrawn from the bottom of the cell by the siphon tube. The second object is attained by charging the exterior space surrounding the membrane with a saturated solution of sulphate of copper, instead of diluted acid; for, on completing the circuit, the electric current passes freely through this solution, and no hydrogen makes its appearance upon the conducting plate; but a beautiful pink coating of pure copper is precipitated upon it, and thus perpetually renews its surface.

When the whole battery is properly arranged and charged in this manner, it produces a perfectly equal and steady current of electricity for many hours together. It possesses also the further advantages of enabling us to get rid of all local action by the facility it affords of applying amalgamated zinc; of allowing the replacement of the zinc rods at a very trifling expense; of securing the total absence of any wear of the copper; of requiring no employment of nitric acid, but substituting in its stead materials of greater cheapness, namely, sulphate of copper, and oil of vitriol; the total absence of any annoying fumes; and lastly, the facility and perfection with which all metallic communications may be made and their arrangements varied.